Calhoun: The NPS Institutional Archive

DSpace Repository

Theses and Dissertations | 1. Thesis and Dissertation Collection, all items

1990-09

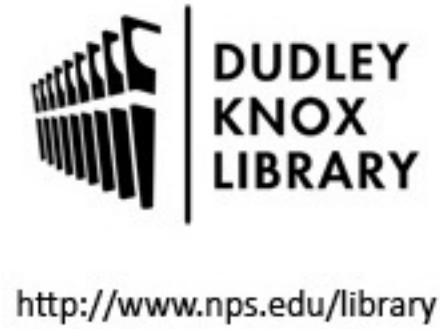
Measuring the effectiveness of information systems

Cyrus, Angela W.

Monterey, California. Naval Postgraduate School

http://hdl.handle.net/10945/30950

Downloaded from NPS Archive: Calhoun



http://www.nps.edu/library

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

NAVAL POSTGRADUATE SCHOOL
Monterey, California

AD-A246 007

DTIC
ELECTE
FEB 18 1992
S B D

THESIS

MEASURING THE EFFECTIVENESS
OF INFORMATION SYSTEMS

by

Angela W. Cyrus
JUNE 1991

Thesis Advisor: William Haga
Thesis Co-Advisor: Moshe Zviran

Approved for public release: Distribution is unlimited

92-03491

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release: Distribution is unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b. OFFICE SYMBOL (If applicable) AS	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS (City, State and ZIP Code) Monterey, CA 93943-5000	7b. ADDRESS (City, State, and ZIP Code) Monterey, CA 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBER PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
MEASURING THE EFFECTIVENESS OF INFORMATION SYSTEMS

12. PERSONAL AUTHORS
ANGELA W. CYRUS

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Master's Thesis	FROM_____ TO_____	JUNE 1991	70

16 SUPPLEMENTARY NOTATION
The views expressed are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block numbers)
FIELD	GROUP	SUB-GROUP	effectiveness in Information Systems (IS)

19. ABSTRACT (Continue on reverse if necessary and identify by block numbers)

Measuring the effectiveness of information systems (IS) is an issue that has generated debate and research among academics and practitioners. This thesis consolidates the numerous and various approaches to measuring IS effectiveness into six general schools of thought: user satisfaction, system usage, performance/ usefulness, productivity, value analysis and cost-benefit analysis. It then presents a model for examining the various linkages that exist among the IS effectiveness measures. These linkages include: user satisfaction and system usage, system usage and performance, performance and productivity, and productivity and cost justification.

This research provides a user a summary of the IS effectiveness literature of the past two decades and a consolidated reference for measuring the effectiveness of information systems.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT XX UNCLASSIFIED/UNLIMITED __ SAME AS RPT __ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL William Haga	22b. TELEPHONE (Include Area Code) (408) 646-3094 22c. OFFICE SYMBOL AS/Hg

Approved for public release: Distribution is unlimited

Measuring the Effectiveness
of Information Systems

by

Angela W. Cyrus
Lieutenant, United States Navy
B.A., Mississippi State University 1983

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE
IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL

JUNE 1991

Author: [redacted]
Angela W. Cyrus

Approved by: [redacted]
William Haga, Thesis Advisor

[redacted]
Moshe Zviran, Co-Advisor

[redacted]
David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

Measuring the effectiveness of information systems (IS) is an issue that has generated debate and research among academics and practitioners. This thesis consolidates the numerous and various approaches to measuring IS effectiveness into six general schools of thought: user satisfaction, system usage, performance/ usefulness, productivity, value analysis and cost-benefit analysis. It then presents a model for examining the various linkages that exist among the IS effectiveness measures. These linkages include: user satisfaction and system usage, system usage and performance, performance and productivity, and productivity and cost justification.

This research provides a user a summary of the IS effectiveness literature of the past two decades and a consolidated reference for measuring the effectiveness of information systems.

Accession For
NTIS GRA&I ☑
DTIC TAB ☐
Unannounced ☐
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or Special
A-1

TABLE OF CONTENTS

I. INTRODUCTION 1
A. THE PROBLEM AREA 1
B. DEFINING IS EFFECTIVENESS 2
II. MEASURES OF INFORMATION SYSTEMS EFFECTIVENESS . 6
A. GENERAL 6
B. USER SATISFACTION 7
C. SYSTEM USAGE 12
D. SYSTEM PERFORMANCE/USEFULNESS 13
E. PRODUCTIVITY 16
F. VALUE ANALYSIS 22
G. COST BENEFIT ANALYSIS 24
H. SUMMARY 26
III. LINKAGES AMONG IS EFFECTIVENESS MEASURES 27
A. USER SATISFACTION AND SYSTEM USAGE 28
1. User Satisfaction Affects System Usage 29
2. System Usage Affects User Satisfaction 30
B. SYSTEM USAGE AND PERFORMANCE 30
C. SYSTEM PERFORMANCE/ USEFULNESS AFFECTS PRODUCTIVITY 32
D. PRODUCTIVITY AND COST JUSTIFICATION 33
E. SUMMARY 35
IV. USER INVOLVEMENT: A RELATED ISSUE 36
A. INTRODUCTION 36
B. USER INVOLVEMENT 36
C. USER INVOLVEMENT AFFECTS SYSTEM USAGE AND USER SATISFACTION 39
D. TOO MUCH USER INVOLVEMENT 40
E. SUMMARY 42
V. CONCLUSION 43
APPENDIX A: LIST OF JOURNALS 45

APPENDIX B: BAILEY AND PEARSON'S USER SATISFACTION SURVEY 46
APPENDIX C: "DETAILED" USER SATISFACTION INSTRUMENT . . 54
LIST OF REFERENCES 57
INITIAL DISTRIBUTION LIST 63

LIST OF FIGURES

Figure 2.1.	Bailey and Pearson's Seven-Interval Scale	9
Figure 3.1.	Model of Linkages Among IS Effectiveness Measures	27
Figure 4.1.	How User Involvement Affects User Satisfaction and System Usage	37

I. INTRODUCTION

A. THE PROBLEM AREA

An information system (IS) derives its value from the effect it has on the performance of an organization (Coleman and Riley, 1972). This is an issue for IS researchers and practitioners (Alavi, 1989). Researching this issue, three questions are considered:

1. What is IS effectiveness?
2. What evaluation techniques are used to measure IS effectiveness?
3. What relationships exist
   a) among evaluation techniques, and
   b) between evaluation techniques and other factors?

To answer these questions, relevant literature in various IS journals (Appendix A) published between 1970 and 1991 was reviewed. This time-frame was chosen because it reflects the period when researchers addressed effectiveness measures of computer information systems. These systems revolutionized the way of doing business in organizations and it became necessary to explore the benefits of IS investments. This thesis integrates the IS effectiveness literature and provides a consolidated reference for measuring the effectiveness of information systems.

B. DEFINING IS EFFECTIVENESS

The definition of effectiveness in IS has, itself, been a topic of research and discussion (Carlson, 1974; Radecki, 1976; King and Schrems, 1978; Ginzberg, 1978; Kleijnen, 1979; Chandler, 1982; Markus and Robey, 1983; Maggiolini, 1986; Dominick, 1987; Trice and Treacy, 1988; Hufnagel, 1990; Amoroso, 1990; Haga and Zviran, 1990). Researchers are in agreement that IS effectiveness focuses on the organizational effects produced by an information system (Haga and Zviran, 1990). These effects include: user satisfaction with an information system (Lucas, 1974; King and Rodriguez, 1978; Robey and Zeller, 1978; Mahmood and Becker, 1985), usage of an information system (Lucas, 1975; Ginzberg, 1978; Trice and Treacy, 1988), productivity of an information system (Maggiolini, 1986), performance and usefulness of an information system (Franz and Robey, 1986; Miller and Doyle, 1987), cost-benefit analysis (Keim and Janaro, 1982; Lay, 1985), and value-analysis.

These various meanings of effectiveness can also be linked to provide additional insights into IS effectiveness. Such linkages include: how user satisfaction and system usage affect one another (Fishbein and Ajzen, 1975; Srinivasan, 1985; Mahmood and Becker, 1985; Baroudi, et. al, 1986), the effect of an information system's performance on productivity (Bearman, et. al, 1985; Schwartz, 1986), how productivity relates to cost-benefit analysis (Schwartz, 1986), and the

impact of user involvement on system usage and user satisfaction (Baroudi, et. al, 1986; Baronas and Louis, 1988).

The problem for a user is deciding which IS effectiveness measure to apply to a given system. In Chapter II, individual measures of IS effectiveness are discussed and application examples are presented. First, it is appropriate to address the initial question posed in this study: "What is IS effectiveness?"

According to Carlson (1974), IS effectiveness is concerned with those effects on an organization which result from the development and use of an information system. The following are some examples of the effects Carlson describes:

1. Information systems will reduce or increase the cost of operations.
2. Information systems will reduce or increase the growth rate in employment.
3. Information systems will reduce or increase clerical work.
4. Information systems will improve reporting by providing more accurate and more timely reports, with less effort.
5. Information systems will improve or reduce productivity.
6. Information systems will improve decision-making, by providing more timely and more accurate information, by stimulating more interaction among decision-makers, and by providing better projections of the effects of decisions.
7. Information systems will alter the attitudes, activities and interactions of administrators.

Hamilton and Chervany (1981) define IS effectiveness as the "accomplishment of objectives." They assert two general views concerning what IS effectiveness means and how it should be measured. The first view, the goal-centered viewstates that the way to assess information systems effectiveness is first to determine the task objectives of the system and then to develop criterion measures to assess how well the objectives are being achieved. Effectiveness is determined by comparing performance to objectives. An example of the goal-centered view of IS effectiveness is to compare actual costs and benefits to budgeted costs and benefits.

Second is the system-resource view. Effectiveness is determined by attainment of a normative state, e.g., standards for "good" practices. In this view, effectiveness is conceptualized in terms of resource viability rather than in terms of specific task objectives. For example, IS effectiveness in terms of human resources might be indicated by the nature of communication and conflict between IS and user personnel, user participation in system development, or user job satisfaction.

Other definitions of IS effectiveness are embedded in the evaluation techniques. For example, proponents of productivity as a measure of IS effectiveness do not define effectiveness explicitly and separately from productivity. Rather, they demonstrate IS effectiveness (or lack thereof) through various productivity measures. In the following chapter on measures of

IS effectiveness, other definitions, implicit to the effectiveness measure, will emerge.

II. MEASURES OF INFORMATION SYSTEMS EFFECTIVENESS

A. GENERAL

Measurement of the effectiveness of information systems is an issue that has generated debate and research among academics and practitioners. Approaches that have been advocated include usage estimation, user satisfaction, incremental performance in decision making effectiveness, cost-benefit analysis, information economics, utility analysis, performance factors, usefulness of information output, productivity, value-analysis, cost-savings, and benefits produced by a system related to costs.

To consolidate these numerous and varied approaches to measuring IS effectiveness, the ones that were most prevalent in the IS literature were extracted and classified into six general schools of thought:

1. User Satisfaction
2. System Usage
3. Performance/ Usefulness
4. Productivity
5. Cost-Benefit Analysis
6. Value-analysis

Each school of thought is presented, individually, in terms of what the IS effectiveness measure is, why it is important and valid, and its application.

B. USER SATISFACTION

User satisfaction with information systems is important because of its potential effects on organizational goals, quality of user work life, and extent of voluntary usage of systems (Galletta and Lederer, 1989). Researchers have argued that use of a system introduced by an IS organization is directly related to a user community's sense of satisfaction (Mahmood and Becker, 1985). Reliable measurement of user satisfaction is important for providing a summative evaluation for the researcher and a formative evaluation for the practioner (Galletta and Lederer,1989). A researcher might want to investigate relationships of user satisfaction with other variables. Thus, user satisfaction might predict outcomes or be predicted by other variables such as training. Once established, such relationships may provide better understanding of the IS environment.

On the other hand, a practitioner might be more interested in user satisfaction as a feedback mechanism to uncover user perception of strengths and weaknesses. Management could use the strengths for reinforcement and recognition and the weaknesses as the basis for making improvements. Cerullo (1980), in his research, emphasized the importance of user

satisfaction by revealing that IS professionals consider user attitudes to be the single most important success factor.

While seeking a model of computer user satisfaction, Bailey and Pearson (1983) defined user satisfaction as the sum of the user's weighted reactions to a set of factors,

$$S_{ij} = \Sigma R_{ij}W_{ij}$$

where R_{ij} = The reaction to factor j by individual i.

W_{ij} = The importance of factor j to individual i.

The model suggests that satisfaction is the sum of one's positive and negative reactions to a set of factors. An individual's feeling must, in this model, be placed somewhere between a "most negative" reaction and a "most pcsitive" reaction. Implementation of the model centers on two different requirements. First, the set of factors comprising the domain of satisfaction must be identified. Second, a vehicle for scaling an individual's reaction to those factors must be found.

Bailey and Pearson (1983) compiled a list of 39 factors making up the domain of user satisfaction. These factors and their definitions appear in Appendix B. In an empirical test, the list of factors was compared to interview responses from 32 middle manager users in eight different organizations. The respondents ranked factors in order of relative importance to their own satisfaction. The ranking suggested that individuals differ in the factors which affect their perception of satisfaction. The dimensionality and intensity of an

individual's reaction to a particular factor was measured using the seven-interval scale shown in Figure 2.1.

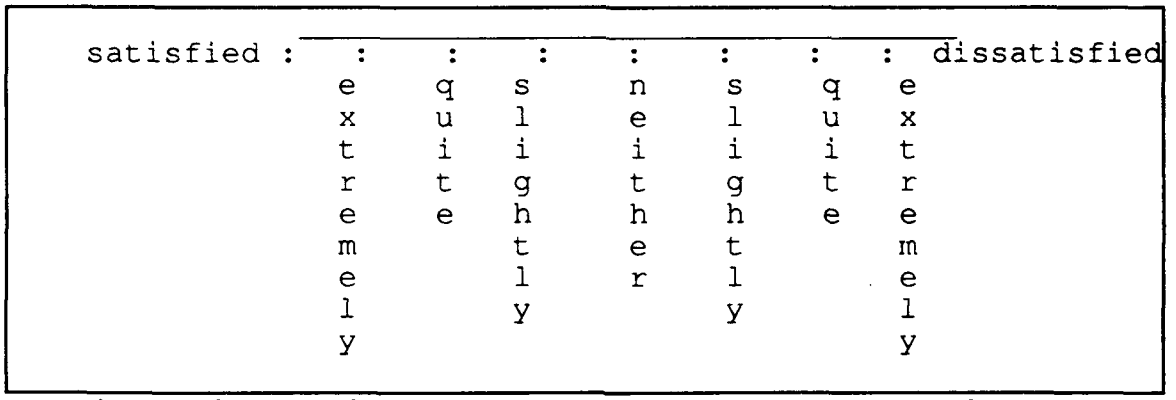


Figure 2.1. Bailey and Pearson's Seven-Interval Scale

This vehicle for measuring a user's reactions hinged on the definition of satisfaction as a bi-dimensional attitude affected by a variety of factors (Bailey and Pearson, 1983).

Ives, et. al.(1983) refined and abbreviated Bailey and Pearson's (1983) instrument into a short, 13-item questionnaire (Appendix C), referred to as the "detailed" instrument (Galletta and Lederer, 1989). Factor analysis identified three factors of user satisfaction: the information system product (quality of output), support (quality and service of the IS function), and involvement (knowledge of the systems or involvement in the development of the systems). The detailed user satisfaction instrument is increasingly used in IS attitude research and according to Galletta and Lederer (1989), is probably the most refined measure of user satisfaction to date. Additionally, Sanders (1984) developed

an instrument to measure satisfaction with decision support systems.

There are criticisms of the user satisfaction surveys. These instruments attempt to measure the success of a system in terms of users' feelings - are they satisfied or dissatisfied with an information system (Hufnagel,1990). Proponents of the user satisfaction approach argue that the subjective assessments that result provide "a meaningful surrogate for the critical but unmeasurable result of an information system, namely, changes in organizational effectiveness" (Ives, et.al.,1983). However, the subjective aspect of user satisfaction surveys has led some researchers to question the widespread acceptance of these evaluation tools. Davis and Srinivasan (1988) point out the user satisfaction approach ultimately hinges on three assumptions: first, the perception of the user with regard to the system being used is an accurate indicator of system effectiveness; second, the perceptions of several users of a system can be aggregated to arrive at an overall assessment of the system under study; and third, user satisfaction with a system can be accurately measured.

An automated system which is perceived by the user to be unsuccessful is unsuccessful, regardless of how good it may be, and vice versa (Martin and Trumbly, 1986). Hufnagel (1990) concluded in his empirical research that users discounted the contribution of an IS when things went well and blamed the

system when things went poorly. This, he claimed, suggested that user satisfaction may be a "less than adequate" surrogate measure for system effectiveness because the actual contribution of an IS is ambiguous or difficult to quantify from a user's perspective. For example, it may be troublesome as a surrogate for effectiveness when users are inexperienced at performing the task in question, do not have a good understanding of how the system actually works, or are otherwise unable to judge the impact system use has had on their outcomes. Expert systems and some types of decision support systems that are specifically designed to aid novice users may be especially vulnerable to the problem of causal attributions if users expect that the answers provided by the system will necessarily be correct (Hufnagel,1990).

With its shortcomings, academicians and practitioners agree that the IS field has advanced as a result of the research on user satisfaction. The development of instruments with which to measure user satisfaction has encouraged more widespread incorporation of this approach in research and its use by practitioners in evaluating system effectiveness. To the extent that the scales of Bailey and Pearson (1983), Ives, et. al., (1983) and others are valid and reliable, they provide information about the overall satisfaction with IS products and services. In addition, they provide a standard for making comparisons across organizational units and over time within units. They are also relatively simple and

inexpensive to administer. Without minimizing these contributions, a number of theoretical and practical issues related to user satisfaction remain to be resolved (Melone, 1990).

C. SYSTEM USAGE

In addition to user satisfaction, an approach to evaluating IS effectiveness that is prevalent in the IS literature is behavioral and focuses on system usage. This approach was proposed by Ein-Dor and Segev (1978) and has often been used in empirical research (Cheney and Dickson, 1982; Baroudi, et. al., 1986). System usage can be subdivided into offline usage, where user-system interaction is limited to the use of printed reports output by the system or to accesses through an intermediary and online usage, where a user interacts with a system through a terminal.

The amount of use an individual, group, or organization makes of an information system is a variable in measuring IS effectiveness. For example, poor systems may require more usage and vice versa. Many times it is used as an independent variable when studying the impact that an information system has had on the process, structure or performance of an organization (Trice and Treacy, 1988). System use or utilization is implicitly defined by researchers as either the amount of effort expended interacting with an information system or, less frequently, as the number of reports or other

information products generated by the information system per unit time (Trice and Treacy, 1988). Examples include frequency and the number of computer sessions, connect time, time spent using different system functions, number of records updated, and keystrokes or carriage returns. There are instances, however, where a high level of system usage is not a sign of successful implementation or IS effectiveness. Two different types of use should be distinguished: voluntary and involuntary. According to Lucas (1978), the use of a model is a good indicator when usage is voluntary. If usage is voluntary, then a high level of use means that the user perceives some benefits from the information system.

Although system usage is a variable that appears in various aspects of measuring IS effectiveness, researchers find it inadequate as a stand-alone measure (Ginzberg, 1978). Linked with performance and user satisfaction, system usage has broader application. These relationships are discussed in Chapter III which addresses linkages among effectiveness measures.

D. SYSTEM PERFORMANCE/USEFULNESS

The performance/usefulness of information systems can be evaluated from two different perspectives. One focuses on the computer system domain and the other on user domain. Each has its own goals and measures. In the computer system domain, performance is measured in terms of resource utilization, cost

and efficiency while in the user domain throughput, reliability, and response times are common measures.

In some operating environments, it is quite possible to design a system such that good performance for one or more users is gained at the expense of other users. Furthermore, because system resources may be used by different users, improving the performance characteristics of one or more resources for the benefit of specific users may have a detrimental effect on overall performance. The problem presented to the analyst is to configure a system which satisfies the users' effectiveness criteria while simultaneously achieving system performance criteria (Chandler, 1982).

Generally, system performance can be thought of as "is the system doing what it is supposed to do?" When the system has a high percentage of "up-time," produces complete and accurate information in a timely fashion, then performance is thought to be favorable. Procedures and tools should be developed and implemented to monitor resource performance against performance standards and targeted objectives (Ameen, 1989). Substandard performance may portend inefficiency or ineffectiveness in providing a particular user service. When evaluating performance, Ameen (1989) proposed the following four steps:

1. Identify critical performance variables

2. Establish methods to collect, measure and analyze performance

3. Determine the nature of corrective action

4. Evaluate the evaluation process itself

One of the most difficult tasks is selection of performance criteria. While common criteria such as hardware or software response time are typically used throughout the industry, it is critical to select the variables which best indicate resource performance for the particular organization of interest. There are two general categories of measures: variables pertaining to efficiency and variables pertaining to effectiveness (Ameen,1989). If efficiency measures are emphasized over effectiveness measures, costs may decrease and usage and throughput may increase, but the quality and timeliness of the resoure output will probably decline. The reverse is true if effectiveness scores are weighted more heavily than efficiency measures.

Other techniques for evaluating performance include benchmarking (the sizing of a targeted CPU against the workload) or stress testing (the measurement of workload impact of concurrent usage) and simulation (the prediction of workload behavior under varying conditions). A newer technique is the expert performance control monitoring system which uses artificial intelligence to direct users through a series of questions and to recommend courses of action. Hardware and

software monitors measure performance of computer equipment and applications. These tools assist in understanding system behavior, identifying bottlenecks and determining the need for system tuning and capacity planning.

Realizing that measures of system effectiveness are interrelated, the major purpose of performance evaluations are to create and maintain good user relations; to enable personnel to make decisions about the computing environment; and to ensure that the needed service is being provided to the organization in an efficient and effective manner (Ameen, 1989).

E. PRODUCTIVITY

Productivity is another approach to measuring IS effectiveness. In the area of computer use and productivity, Mason (1984) suggests that information systems generally serve three purposes. One of them is reducing costs; another is increasing revenues; the third is providing better services. He suggests that the main benefits of IS are the savings which are possible in work-time when the systems are implemented. Maggiolini (1986) advocates that IS, particularly in the area of office automation, improves efficiency by automating all or some parts of the office information process; eliminating some of the transformations of medium; eliminating or reducing the shadow activities or functions; and speeding up the

information process itself. This, he claims, increases overall productivity.

In defining productivity, Bain (1982) contends that productivity is not a measure of output produced. He says instead that it is a measure of how well resources are combined to accomplish specific results. He explains that a concept of productivity must account for an interplay between factors such as quality, availability of materials, scale of operations, the rate of capacity, the rate of capacity utilization, the attitude and skill level of the work force, and the motivation and effectiveness of management. The way in which these factors interrelate has an important bearing on the resulting productivity.

Productivity is the ratio of the number of units of output to the number of units of input:

Productivity = output/input.

Productivity rises when the number of units of output increases while input holds steady; or conversely, when the number of units of output remains fixed and the number of units of input is decreased. Productivity can be measured by converting input and output units to their respective dollar equivalents.

Borko (1983) says the concept of productivity measurement is clear, and the formula relatively easy to apply in situations where the input and output units are readily identifiable and countable. He contends, however, that such

measures are much more difficult to apply when measuring the productivity of office workers, and especially knowledge workers. The output of an office is varied and largely intangible (Borko, 1983).

He states that effective management is largely dependent upon the availability of current and reliable information processed to facilitate decision making and enhance productivity. He says that the studies that have been performed on office information processing have concerned clerical productivity which lends itself more readily to quantitative measure. He further contends that clerical workers, however, account for only one-fourth to one-third of all white collar office costs, and the clerical worker alone is not the greatest source of potential savings. The larger segment of the office environment includes knowledge workers, e.g. managers, professionals and technical workers. Since the cost of knowledge workers is significantly greater than the cost of clerical personnel, an increase in knowledge worker productivity can result in significant savings (Borko, 1983). Since knowledge workers exert the greatest influence on the decision making process, changes in their IS practices could have a major impact on their productivity and the productivity of other office workers.

Sink defines productivity measurement as "the selection of physical, temporal, and perceptual measures for both input

variables and output variables and the development of a ratio of output measure(s) to input measure(s)." (Sink, 1985, p. 25)

Sink says there are two basic categories of pure productivity measures. The first are static productivity ratios in which measures of output are divided by measures of input for a given period of time. The second category are dynamic productivity indexes which give a static productivity ratio at some previous period in time. There are three types of productivity measures within each category:

1. The partial factor measure which uses one class of input such as labor or capital,
2. the multifactor measure which uses more than one class and,
3. the total measure which uses all classes of inputs.

Each of the three types represents a ratio of output to input. However, they differ in terms of how much input is captured in the denominator of the equation.

Sink defined productivity as the relationship between quantities of outputs from a system and quantities of inputs into that same system. Dissecting this definition, it can be seen that the numerator contains an aspect of effectiveness in the way of quality and quantity. While on the other hand, the denominator contains an aspect of efficiency in the way resources are actually consumed.

Mason (1978) says defining and measuring the output of any system is difficult, especially if the output is rather intangible. Much of the original development of output measures and productivity analysis occurred in industry where such tangible measures such as "automobiles produced per man-hour" or "ton miles moved per man-hour" are reasonable output/input indicators of productivity. He describes an important class of systems for which output measures are difficult to define. These are systems whose output is primarily information. Essentially, information involves the means by which one system affects another. So an information system is a component of any system and a critical element in the linkage between many diverse systems (Mason,1978). Systems which produce information as an output include accounting, data processing, research and development, education, communication media, and entertainment. These systems not only produce information as an output but also consume resources in the process. Consequently, concerns for efficiency require that the output of these systems be related to the input resources consumed. Only then can managerial judgements be made as to the appropriateness of the allocations. This measurement requires understanding the fundamental nature of information and of alternative ways of measuring it.

Shannon and Weaver (1963) distinguish among the technical level, semantic level and influence level when measuring an information system's output. The technical level refers to the

physical manipulation of data and media. The semantic level refers to the logical units of meaning handled by the system. Finally, the influence level refers to units of change in behavior, attitude or cognition created by the system.

Shannon and Weaver (1963) explain that basic productivity measurement may be obtained at the technical level by comparing the number of units of output as measured by the units to a measure of resources consumed by the system; for example, bits processed per dollar of expenditure. Basic productivity measures are obtained at the semantic level by relating the number of units of output to a measure of resources consumed by the system; for example words processed per dollar of expenditure. Measures of productivity calculated at the semantic level will be different from measures of productivity calculated at the technical level and are not necessarily correlated.

Finally, he says, the measure of output at the influence level is the number of units of change or affect that takes place in the receiver as a result of receiving information from the producer. A problem to be solved in obtaining measures of output at the influence level is to determine the amount of the response or change due to the information received from the producer and not due to other causes (Shannon and Weaver, 1963).

In a given circumstance, one would want to choose one or more of these productivity measures to describe the key

aspects of the system under study. These output measures may be related to a variety of input measures to form productivity measures for the information system as a whole.

While productivity is an applicable measure for the effectiveness of many information systems, it is less than adequate for assessing decision support systems and the like. In that case, the value-analysis approach would be more applicable. It is discussed in the following section.

F. VALUE ANALYSIS

Value analysis is an approach used for measuring the effectiveness of decision support systems (DSS). Once a DSS has been up and running in an organization, the question may exist whether to update or scrap the DSS. Value Analysis allows the evaluator to determine what the user is willing to pay in order to keep his present DSS and to determine if there are other benefits that can be added to the DSS. This method was first introduced by Keen (1981) and was divided into eleven steps by Smith (1983). The eleven steps are:

1. Define the benefits to be obtained if a prototype system is developed.
2. Determine the amount the users are willing to pay to obtain the benefits.
3. Determine whether a prototype can be implemented within the "cost threshold" established by the user.
4. Design the prototype and measure its use and cost.

5. Review and extend benefits list if necessary.

6. Define computer hardware and software which would permit a more complete system to be evolved from the prototype.

7. Determine cost of expanding the system.

8. Ask users to determine level of benefits which must be obtained to justify investing in an expanded system.

9. Assuming users provide a feasible new "cost threshold," design a second version of the system.

10. After the second version is implemented, measure its use and costs and determine new cost threshold for a possible third stage of development.

11. Continue steps 5-10 until users and systems designers are satisfied that the best solution has been achieved under existing constraints.

This method allows the users to determine what benefits are important and place a monetary figure to each benefit. The monetary values are based on what the user will be willing to pay to obtain a specific benefit. This approach uses the "quick hit" approach when developin a DSS and utilizes prototypes to get a working model in a users' hands as quickly as possible and at a low initial cost.

The evolving DSS that Value Analysis provides is an excellent way of continually evaluating an organization's DSS. If users are pleased with the initial versions of the DSS, the organization can continually update the DSS to include more functions.

G. COST BENEFIT ANALYSIS

Cost Benefit Analysis (CBA) is an investment decision technique that is applied to information systems. In the early stages of a complex IS design, the lack of specific requirements, the uncertainty of needed manpower requirements, and the inability to estimate intangibles results in poor attempts at cost-benefit analyses (Keim and Janaro, 1982). Some researchers argue that there are instances where incorrect IS decisions have been taken through excessive reliance by the decision-makers on CBA results (Lay, 1985). Opinions on the applicability of CBA to IS range from that of advocating profit and loss evaluations to those that would not attempt any cost-benefit analyses (Mathusz, 1977). Normally applied in the pre-implementation phase, CBA as a planning tool or justification in the IS environment has its shortcomings.

Cost-benefit analysis relies on the fact that costs and benefits can be estimated with reasonable accuracy. If they are not, the net worth of a system will be incorrect and invalid decisions will be made, such as:

1. Setting the incorrect priority for development
2. Rejecting a potentially profitable system
3. Accepting a non-viable project (Lay,1985).

Lay (1985) states that the primary purpose of CBA is to measure the econmic return of an information system which will

assist management in approving a particular information system for development. He describes it as typically consisting of the following five steps:

1. Defining the scope of the project.
2. Evaluating the direct and secondary costs and benefits of the project.
3. Defining the life of the project.
4. Discounting the net present values of benefits.
5. Performing sensitivity analyses.

An examination of the relevance of the CBA technique to IS planning reveals that its shortcomings fall into two categories. The first relates to problems of estimating the costs and benefits of IS projects. The second category deals with costs that cannot be measured at all but should be included in the model.

Keim and Janaro (1982) proposed a phased approach to cost-benefit analysis. It takes into account the system design life cycle and applies a flexible and evolutionary cost-benefit analysis throughout the life cycle. As each stage in the system design defines a more specific system configuaration, the updated CBA is completed using increasingly specific and quantifiable information and evaluation. Such a phased approach will avoid the traditional, unrealistic and inaccurate CBA that rely on a single application at a very early stage of the information system design.

H. SUMMARY

From the numerous and varied approaches to measuring IS effectiveness, the ones most prevalent in the IS effectiveness literature were extracted and classified into six general schools of thought. Those classifications are: user satisfaction, system usage, performance/usefulness, productivity, value analysis and cost benefit analysis. These schools of thought for measuring effectiveness have been discussed individually in terms of what they are, their importance and application. In the next chapter, linkages among these six IS effectiveness measures be addressed. This discussion will be based on a conceptual model presented at the beginning of the following chapter.

III. LINKAGES AMONG IS EFFECTIVENESS MEASURES

The IS effectiveness literature of the past two decades contained reviews of various linkages which existed among the various IS effectiveness measures. these linkages are summarized in the model presented in Figure 3.1. This model depicts relationships among the six schools of thought for measuring IS effectiveness. In the following sections, these linkages are discussed.

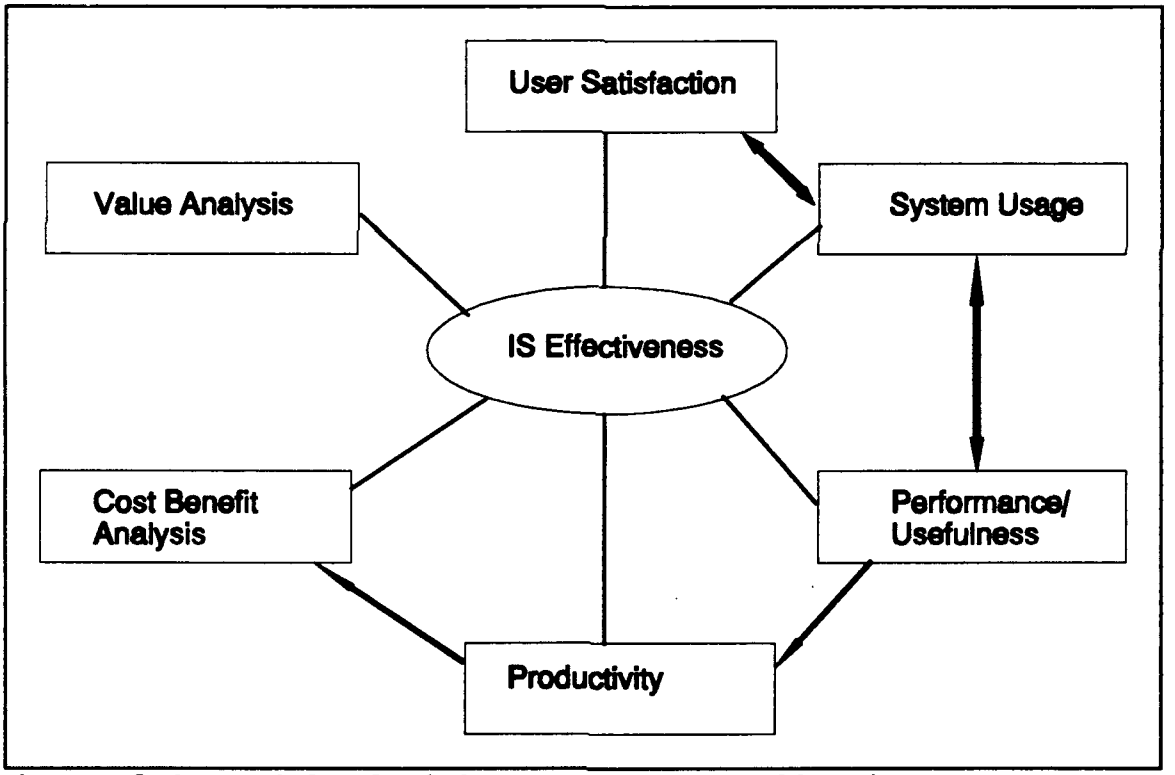


Figure 3.1. Model of Linkages Among IS Effectiveness Measures

A. USER SATISFACTION AND SYSTEM USAGE

The fundamental aim of an organizational information system is to improve individual decision-making performance, and ultimately organizational effectiveness (Raymond, 1990). The difficulty in empirically assessing system effectiveness in this way has led researchers to adopt surrogate constructs that are more easily measurable. Of the two main approaches for evaluating information system success, the first one is behavioral and focuses on system usage. This approach was the one proposed by Ein-Dor and Segev (1978). System usage can be subdivided into offline usage, where user-system interaction is limited to the use of printed reports output by the system or to accesses through an intermediary, and into online usage, where the user interacts himself with the system through a terminal; these are fundamentally different types of user behaviors that are not necessarily related (Srinivasan, 1985).

The second approach in evaluating success centers on user attitudes, more specifically on user satisfaction with various aspects of an information system. This approach is now the most common in the literature (Mahmood and Becker, 1985; Raymond, 1985; Srinivasan and Kaiser, 1987; Tait and Vessey, 1988). Results of empirical studies have, however, been mixed in regard to the relationship between system usage and user satisfaction. While some researchers did not find the two types of measures to be associated significantly (Cheney and Dickson, 1982), others have (Ein-Dor, Segev, Blumenthal and

Millet, 1984; Raymond, 1985). Baroudi, et. al., (1986) suggested that the use of both approaches to measure system effectiveness is warranted in most research situations.

1. User Satisfaction Affects System Usage

User satisfaction is an attitude toward the information system while system usage is a behavior. Fishbein and Ajzen's (1975) model of attitudes and behaviors suggests that attitudes toward an object (in this case an information system) will influence intentions and ultimately influence behavior with respect to that object (the use of the system or its outputs). This framework can be interpreted as supporting the model (Figure 3.1) in that user information satisfaction (an attitude) will lead to system usage (a behavior). Empirical studies have shown that the user's satisfaction with the system will lead to greater system usage (Baroudi, et. al., 1986; Lucas, 1984).

For almost all information systems, some use of the system is required, for example, it may be the only way to process orders or to compute the payroll. However, it is expected that the use of systems beyond basic input and transactions processing is voluntary. For example a user generally decides voluntarily to perform an extensive analysis of an output report instead of just glancing at it. Attitudes have an action component and favorable attitudes are

consistent with high levels of voluntary use of information systems (Lucas, 1974).

2. System Usage Affects User Satisfaction

Dissonance theory (Fishbein and Ajzen, 1975) suggests that behaviors can lead to attitudes. When dissonance with a presently held attitude is created by the performance of a contradictory behavior, the individual may change the belief or attitude to remove or reduce the dissonance. To justify continuing use of the system (assuming the use is voluntary), the individuals may reevaluate the system more positively to reduce the dissonance. Dissonance theory supports Figure 3.1 which suggests that system usage (a behavior) leads to user information satisfaction (an attitude). In the case where use is not voluntary, a poor quality system may lead to unfavorable attitudes.

B. SYSTEM USAGE AND PERFORMANCE

Lucas (1975) states that evaluations of information systems should consider the relationship between the use of systems and performance. He says that in some cases, use of a system may be related to performance and in other instances performance may be a determinant of use. He discusses three relationships between system usage and performance. The first is low performance predicts high levels of use of information provided by an information system. This applies when a problem is ill-defined and low performance stimulates the use of

information, such as comparison with past performance. For problem solving, the decision maker considers alternative actions, evaluates their consequences, selects an alternative and implements it.

The second relationship between usage and performance that Lucas (1974) describes is where high levels of usage predict high performance. In this case the problem is well-defined and an information system providing certain information (such as market forecasts) can contribute directly to performance. The strength of the relationship wil depend on the relevance of the information and the problem solver's ability to analyze alternatives and implement the selected action. Performance is positively related to usage.

The third relationship between usage and performance occurs when the information provided by a system is completely irrelevant. Use of the system obscures the real problems and diverts resources which could be better allocated to other activities (Lucas, 1974). The use of the information system is dysfunctional: under these conditions less usage is expected to predict higher performance. Usage is negatively related to performance.

In his empirical research involving a sales force of a manufacturing firm, Lucas (1974) found that usage and performance are partially determined by situational factors such as length of time in a position, and by personal factors such as age and education. He found that use of an information

system is dependent on attitudes and perceptions about systems in general. Attitudes have an action component: positive attitudes toward consistent with a high level of use of an information system. If attitudes are highly negative, on the other hand, users will minimize the contribution of the system and question the validity of outpu reports. He reported that attitudes and perceptions of computer systems are influenced in turn by the quality of the system as perceived by users.

C. SYSTEM PERFORMANCE/ USEFULNESS AFFECTS PRODUCTIVITY

When an information system is performing well - that is, the system is doing what it is supposed to do, it can positively impact the productivity of the persons using the system as well that of the environment in which the system operates (Bearman, et. al., 1985; Schwartz, 1986). Information is an essential ingredient in office work, in management decision making and in knowledge worker productivity. Automated office information systems are designed to process information more efficiently and more effectively so as to increase the productivity of the office staff and the profitability of the organization (Borko,1983).

Traditionally, new technology was used to facilitate productivity gains in the blue collar work force or in the clerical population. However, in recent years, there has been significant recognition that productivity gains can be realized by improving the technilogical capabilities of

knowledge workers. Knowledge workers include the managerial and professional population (Bearman, et. al., 1985; Borko, 1983). In order to increase productivity in general, it is necessary to concentrate on increasing the productivity of the white collar worker, and one way by which this can be accomplished is by an increased investment in office technology (Borko, 1983).

Mason (1984) noted three general respects in which successful performance of information systems can increase productivtiy. The first is by reducing costs; another is by increasing revenues and the third is by providing better services. Worthley (1990) said, "To hear the computer vendors tell it, computer technology is the answer to a broad range of productivity needs in government"

D. PRODUCTIVITY AND COST JUSTIFICATION

Schwartz (1986), presented a new methodology for cost justification of office information systems in engineering environments. The methodology is called the "hedonic" wage model. It is based on the fact that the allocation of labor resources in an organization tends to conform to certain logical economic criteria. These criteria, along with the information on the costs of labor and on how workers spend their time, permit inferences about the organizational values of key activities. His hedonic wage model estimates the implicit marginal values to the organization of key activities

by using data on organizatonal structure, work activities, resource allocation and costs. These marginal values provide the basis for estimating the financial impacts of a proposed system on an organization by placing a dollar value on improvements in worker efficiency and effectiveness.

Efficiency refers to the additional amount of work in an activity which can be accomplished in the same amount of time. For example, if an information system allows each hour spent in data analysis to produce ten percent more output, the increase in efficiency in that activity is ten percent.

Effectiveness refers to the amount of time workers spend doing their principal activities rather than support activities. An increase in effectiveness is achieved when an individual's work profile is modified so more time is spent doing high value rather than low value work. The work profile is a matrix identifying how much time is routinely spent in each of the key acitvity categories by each type of worker. In his particular study, Schwartz (986) collected data for a work profile using a time log which was distributed to a representative sample of employees. He then calculated the implicit marginal values of the key activity categories in the engineering organization. He first determined whether the number of employees in each job category represented an unconstrained equilibrium and then defined and solved a set of simultaneous equations which incorporated the data and assumptions. The unknown variables in the equations are the

implicit marginal values of the activity categories and the coefficients are the work profile perentages. The result was a more credible lower-bound estimate of the financial value of an information system to an organization. Lastly, the model used the cost-benefit analysis. This produced a bottom-line value for the proposed information system.

E. SUMMARY

Linkages exist among the various IS effectiveness measures. Some of the linkages which are prevalent in the IS effectiveness literature are: user satisfaction and system usage; system usage and performance/usefulness; performance and productivity, and productivity and cost-benefit analysis.

Two additional linkages which emerge in the IS effectiveness literature concern user involvement. A discussion of this takes place in the following chapter.

IV. USER INVOLVEMENT: A RELATED ISSUE

A. INTRODUCTION

User involvement is not a vehicle for measuring the effectiveness of information systems. However, it is an issue that emerges in the IS effectiveness literature. Its effect on the surrogate measures user satisfaction and system usage (Figure 4.1) warrant brief discussion and that is the intent of this chapter.

B. USER INVOLVEMENT

Before discussing the linkages that exist between user involvement and IS effectiveness measures, it is appropriate to discuss user involvement as a separate entity related to IS effectiveness.

When considering the effectiveness of an information system, one theme is becoming more prevalent in the relevant literature. That is, involving the users in the conceptual phase of the IS and soliciting their inputs throughout its implementation. An empirical study conducted by Baronas and Louis (1988) concluded that users' involvement in system installation is effective because it restores or enhances their perceived control over their work. In particular, the study involved payroll and personnel employees from 35 state government agencies. Forty-three people were introduced to a

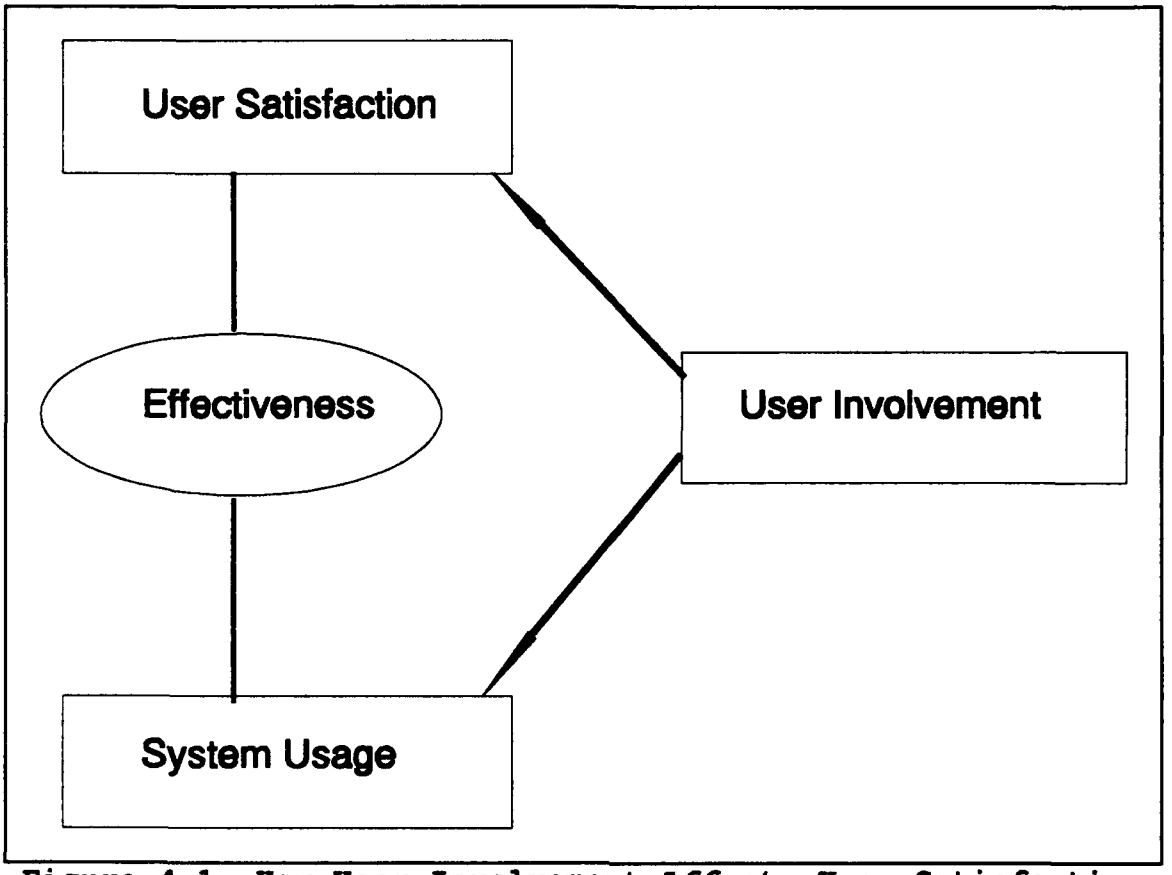


Figure 4.1. How User Involvement Affects User Satisfaction and System Usage

new system in a traditional way (no formal orientation), while the remaining forty-nine went through a special customized introduction process which focused on making them feel comfortable that the new system would not cause them to lose control over their work. In effect, those who received the special training were:

1. Significantly more satisfied with the new system
2. More positive in their perception of interacting with systems implementors

3. Happier with the new system than with the old systems.

According to Ives and Olson (1984), user involvement is predicted to increase user acceptance by:

1. Developing realistic expectations about system capabilities (Gibson,1977);
2. Providing an arena for bargaining and conflict resolution about design issues (Keen, 1981);
3. Leading to system ownership by users (Robey and Farrow, 1982);
4. Decreasing user resistance to change (Lucas, 1974);
5. Commiting users to the system (Lucas,1974; Markus, 1983).

User involvement is also predicted to improve system quality by (Ives and Olson, 1984):

1. Providing a more accurate and complete assessment of use information requirements (Norton and McFarlan, 1975; Robey and Farrow, 1982);
2. Providing expertise about the organization the system is to support (Lucas, 1974);
3. Avoiding development of unacceptable or unimportant features (Robey and Farrow, 1982);
4. Improving user understanding of the system (Lucas, 1974; Robey and Farrow, 1982).

The informations systems literature shows general agreement that the success of information systems can be improved by involving the user in the development of those systems. Involving users in systems development and

implementation can impact positively on other aspects of IS effectiveness such as system usage and user satisfaction.

C. USER INVOLVEMENT AFFECTS SYSTEM USAGE AND USER SATISFACTION

User involvement in information system development is considered an important mechanism for improving system quality and ensuring successful implementation. The assumption that user involvement leads to system usage and/or user satisfaction (Figure 4.1) was examined in an empirical study by Baroudi, et.al. (1984) in a survey of 200 production managers. The results demonstrated that user involvement in the development of information systems will enhance both system usage and the user's satisfaction with the system.

Baronas and Louis (1988) conducted an empirical study involving ninety-two payroll and personnel employees from 35 state government agencies to illustrate the point that user involvement in system implementation would increase overall satisfaction with the information system. In the study, 43 people were introduced to the system in the traditional way, while the remaining 49 underwent special customized training which focused on making them feel comfortable that the new system would not cause them to lose control over their work. Those who received the special training were significantly more satisfied with the new system; more positive in their

perception of interacting with systems implementors; and happier with the new system than the old systems.

Franz and Robey (1986) further illustrate the impact of user involvement in an empirical study investigating organizational factors related to user involvement in information system development and perceived system usefulness. They used a sample of one hundred and eighteen managers in thirty-four companies. Their results showed that user involvement in design and implementation is related positively to users' perceptions of system usefulness. Similarly, Edstrom (1977), in a study of 16 companies, showed that users perceive systems to be more successful when they are able to influence the designs through effective communication.

D. TOO MUCH USER INVOLVEMENT

While user involvement in system development has benefits, Cash, et. al. point out that the complexities of developing IS has forced the creation of specialized departments, resulting in a series of strained relationships with users of their service. They explain that this has been an enduring headache from the start. The specialists have appropriately developed their own language systems to communicate with each other while general management has quite a different language. Coordination issues tend to be complex.

According to Cash, et. al. when users have too much dominance in system development the following implications emerge:

1. Too much emphasis on problem focus
2. Information technology stays out of control
3. Explosive growth in the number of new systems and supporting staff
4. Multiple suppliers delivering services
5. Lack of standardization and control over data hygiene and system
6. Hard evidence of benefits non-existent
7. Soft evidence of benefits not organized
8. Few measurements/objectives for new systems
9. Technical advice of IS department not sought, or if received, considered irrelavant
10. User buying design/construction/maintainance services and even operations from outside
11. User building networks to own unique needs (not corporate needs)
12. While some users are growing rapidly in experience and use, other users feel nothing is relevant because they do not understand
13. No coordinated effort for technology transfer or learning from experience between users
14. Growth in duplication of technical staffs
15. Communications costs are rising dramatically through redundancy

A user tends toward short-term need fulfillment (at the expense of long-term IS hygiene and orderly development). An

IS department, on the other hand, can become preoccupied with the mastery of technology and an orderly development plan at the risk of slow response to legimate user needs. Effectively balancing the roles of these twc groups is a complex task, which must be dealt with in the context of the corporate culture and the potential strategic IS role.

E. SUMMARY

While user involvement is not a measure of IS effectiveness, it is a related issue. User involvement has been shown empirically to affect user satisfaction and system usage, which are IS effectiveness measures. Although some researchers advocate involving users in system development and implementation, others have identified potential drawbacks to too much user involvement.

V. CONCLUSION

IS effectiveness is concerned with those effects on an organization which result from the development and use of an information system (Carlson, 1974). It can also be described as the accomplishment of objectives (Hamilton and Chervany, 1981). It can be determined by comparing performance to objectives or by attainment of a normative state (Hamilton and Chervany, 1981). Other definitions of IS effectiveness are embedded in the evaluation techniques, such as increased productivity, a satisfied user community, or successful performance of an IS.

The numerous and various approaches to measuring IS effectiveness can be classified into six general schools of thought: user satisfaction, system usage, performance/usefulness, productivity, value analysis and cost-benefit analysis. In addition, several linkages exist among the various measures of IS effectiveness. These include: user satisfaction and system usage; system usage and performance; performance and productivity, and productivity and cost-benefit analysis.

User involvement, while not an IS effectiveness measure, is a related issue that emerges in the IS effectiveness literature. It has been shown to affect user satisfaction and system usage. While there are many advocates of user

involvement, some potential drawbacks to too much user involvement have been identified.

The definition of IS effectiveness remains a topic of research and discussion among practitioners and researchers. Evaluation of IS effectiveness is complicated by its multi-dimensionality, its quantitative and qualitative aspects, and the multiple and often conflicting evaluator viewpoints. For IS effectiveness researchers and practitioners, it will be beneficial to incorporate multiple viewpoints of multiple objectives and performance measures into the complete assessment of IS effectiveness (Hamilton and Chervany, 1981).

APPENDIX A: LIST OF JOURNALS

COMMUNICATION OF THE ACM

COMPUTING SURVEYS

DATA BASE

DECISION SCIENCES

HUMAN RELATIONS

IEEE

INFORMATION AND MANAGEMENT

INFORMATION PROCESSING AND MANAGEMENT

INTERFACES

JOURNAL OF SYSTEMS MANAGEMENT

JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE

JOURNAL OF THE MANAGEMENT INFORMATION SYSTEMS

MANAGEMENT INFORMATICS

MANAGEMENT SCIENCE

MIS QUARTERLY

OMEGA

PUBLIC PRODUCTIVITY REVIEW

SYSTEMS, OBJECTIVES, SOLUTIONS

APPENDIX B: BAILEY AND PEARSON'S USER SATISFACTION SURVEY

1. *Top management involvement*: the positive or negative degree of interest, enthusiasm, support, or participation of any management level above the user's own level toward computer-based information systems or services or toward the computer staff which supports them.

strong vs weak
consistent vs inconsistent
good vs bad
significant vs insignificant

2. *Organizational competition with the IS unit*: the contention between the respondent's organizational unit and the IS unit when vying for organizational resources or for responsibility for success or failure of information systems or services of interest to both parties.

productive vs destructive
rational vs emotional
low vs high
harmonious vs dissonant

3. *Priorities determination*: policies and procedures which establish precedence for the allocation of IS resources and services between different organizational units and their requests.

fair vs unfair
consistent vs inconsistent
just vs unjust
precise vs vague

4. *Charge-back method of payment for services*: the schedule of charges and the procedures for assessing users on a pro rata basis for the IS resouces and services that they utilize.

just vs unjust
reasonable vs unreasonable
consistent vs inconsistent
known vs unknown

5. *Relationship with the IS staff*: the manner and methods of interaction, conduct, and association between the user and the IS staff.

harmonious vs dissonant
good vs bad
cooperative vs uncooperative
candid vs deceitful

6. *Communication with the IS staff*: the manner and methods of information exchange between the user and IS staff.

harmonious vs dissonant
productive vs destructive
precise vs vague
meaningful vs meaningless

7. *Technical competence of the IS staff*: the computer technology skills and expertise exhibited by the IS staff.

current vs obselete
sufficient vs insufficient
superior vs inferior
high vs low

8. *Attitude of the IS staff*: the willingness and commitment of the IS staff to subjugate external professional goals in favor of organizationally directed goals and tasks.

user-oriented vs self-centered
cooperative vs belligerent
courteous vs discourteous
positive vs negative

9. *Schedule of products and services*: the IS center timetable for production of information system outputs and for provision of computer-based services.

good vs bad
regular vs irregular
reasonable vs unreasonable
acceptable vs unacceptable

10. *Time required for new development*: the elapsed time between the user's request for new applications and the design, development, and implementation of the application systems by the IS staff.

short vs long
dependable vs undependable
reasonable vs unreasonable
acceptable vs unacceptable

11. *Processing of change requests*: the manner, method and required time with which the IS staff responds to user requests for changes in existing computer-based information systems or services.

fast vs slow
timely vs untimely
simple vs complex
flexible vs rigid

12. *Vendor support*: the type and quality of the ser ice rendered by a vendor, either directly or indirectly, to the user to maintain the hardware or software required by that organizational status.

skilled vs bungling
sufficient vs insufficient
eager vs indifferent
consistent vs inconsistent

13. *Response/turnaround time*: the elapsed time between a user-initiated reques for service and a reply to that request. Response time generally refers to the elapsed time for terminal type request or entry. Turnaround time generally refers to the elapsed time for execution of a program submitted or requested by a user and the return of the output to that user.

fast vs slow
good vs bad
consistent vs inconsistent
reasonable vs unreasonable

14. *Means of input/output*: the method and medium by which a user inputs data to and receives output from the IS center.

convenient vs inconvenient
clear vs hazy
efficient vs inefficient
organized vs disorganized

15. *Convenience of access*: the ease or difficulty with which the user may act to utilize the capability of the computer system.

convenient vs inconvenient
good vs bad
easy vs difficult
efficient vs inefficient

16. *Accuracy*: the correctness of the output information.

accurate vs inaccurate
high vs low
consistent vs inconsistent
sufficient vs insufficient

17. *Timeliness*: the availability of the output information at a time suitable for its use.

timely vs untimely
reasonable vs unreasonable
consistent vs inconsistent
punctual vs tardy

18. *Precision*: the variability of the output information form that which it purports to measure.

sufficient vs insufficient
consistent vs inconsistent
high vs low
definite vs uncertain

19. *Reliability*: the consistency and dependability of the output information.

consistent vs inconsistent
high vs low
superior vs inferior
sufficient vs insufficient

20. *Currency*: the age of the output information.

good vs bad
timely vs untimely
adequate vs inadequate
reasonable vs unreasonable

21. *Completeness*: the comprehensiveness of the output information content.

complete vs incomplete
consistent vs inconsistent
sufficient vs insufficient
adequate vs inadequate

22. *Format of output*: the material design of the layout and display of the output contents.

good vs bad
simple vs complex
readable vs unreadable
useful vs useless

23. *Language*: the set of vocabulary, syntax, and grammatical rules used to interact with the computer systems.

simple vs complex
powerful vs weak
easy vs difficult
easy-to-use vs hard-to-use

24. *Volume of output*: the amount of information conveyed to a user from computer-based systems. This is expressed not only by the number of reports or outputs but also by the voluminousness of the output contents.

concise vs redundant
sufficient vs insufficient
necessary vs unnecessary
reasonable vs unreasonable

25. *Relevancy*: the degree of confruence between what the user wants or requires and what is provided by the information products and services.

useful vs useless
relevant vs irrelevant
clear vs hazy
good vs bad

26. *Error recovery*: the methods and policies governing correction and rerun of system outputs that incorrect.

fast vs slow
superior vs inferior
complete vs incomplete
simple vs complex

27. *Security of data*: the safeguarding of data from misappropriation or unauthorized alterationor loss.

secure vs insecure
good vs bad
definite vs uncertain
complete vs incomplete

28. *Documentation*: the recorded description of an information system. This includes formal instructions for the utilization of the system.

clear vs hazy
available vs unavailable
complete vs incomplete
current vs obselete

29. *Expectations*: the set of attributes or features of the computer-based informtion products or services that a user considers reasonable and due from the computer-based information support rendered within his organization.

pleased vs displeased
high vs low
definite vs uncertain
optimistic vs pessimistic

30. *Understanding of systems*: the degree of comprehension that a user possesses about the computer-based information systems or services that are provided.

high vs low
sufficient vs insufficient
complete vs incomplete
easy vs hard

31. *Perceived utility*: the user's judgement about the relative balance between the cost and tbe considered usefulness of the computer-based informtion products or services that are provided. The costs include any costs related to providing the resource, including money, time, manpower, and opportunity. The usefulness includes any benefits that the user believes to be derived from the support.

high vs low
positive vs negative
sufficient vs insufficient
useful vs useless

32. *Confidence in the systems*: the user's feelings of assurance or certainty about the systems provided.

high vs low
strong vs weak
definite vs uncertain
good vs bad

33. *Feeling of participation*: the degree of involvement and commitment which the user shares with the IS staff and others toward the functioning of the computer-based information systems and services.

positive vs negative
encouraged vs repelled
sufficient vs insufficient
involved vs uninvolved

34. *Feeling of control*: the user's awareness of the personal power or lack of power to regulate, direct or dominate the development, alteration, and the execution of the computer-based information systems or services which serve the user's perceived function.

high vs low
sufficient vs insufficient
precise vs vague
strong vs weak

35. *Degree of training*: the amount of specialized instruction and practice that is afforded to the user to increase the user's proficiency in utilizing the computer capability that is available.

complete vs incomplete
sufficient vs insufficient
high vs low
superior vs inferior

36. *Job effects*: the changes in job freedom and job performance that are ascertained by the user as resulting from modifications induced by the computer-based information systems and services.

liberating vs inhibiting
significant vs insignificant
good vs bad
valuable vs worthless

37. *Organizational Positions of the IS function*: the hierarchical relationship of the IS function to the overall organizational structure.

appropriate vs inappropriate
strong vs weak
clear vs hazy
progressive vs regressive

38. *Flexibility of Systems*: the capacity of the information system to change or to adjust in response to new conditions, demands, or circumstances.

flexible vs rigid
versatile vs limited
sufficient vs insufficient
high vs low

39. *Integration of Systems*: the ability of systems to communicate/transmit data between systems servicing different functional areas.

complete vs incomplete
sufficient vs insufficient
successful vs unsuccessful
good vs bad

APPENDIX C: "DETAILED" USER SATISFACTION INSTRUMENT
Ives, Olson and Baroudi (1983) Survey

This survey is designed to measure your personal feelings about the computer-based informtion systems used at your firm.

Please check each scale in the position that describes your evaluation of the factor being judged. Please check only one position on each scale in (rather than between) the space provided.

Work rapidly; rely on your first impressions. Please do not omit any scale.

1. Relationship with IS staff:

harmonious :__:__:__:__:__:__:__: dissonant

good :__:__:__:__:__:__:__: bad

2. Processing of requests for changes to existing systems:

fast :__:__:__:__:__:__:__: slow

timely :__:__:__:__:__:__:__: untimely

3. Degree of IS training provided to users:

complete :__:__:__:__:__:__:__: incomplete

high :__:__:__:__:__:__:__: low

4. Users' understanding of systems:

sufficient :__:__:__:__:__:__:__: insufficient

complete :__:__:__:__:__:__:__: incomplete

5. Users' feelings of participation:

positive :__:__:__:__:__:__:__: negative

sufficient :__:__:__:__:__:__:__: insufficient

6. Attitude of the IS staff:

cooperative :__:__:__:__:__:__:__: belligerent

positive :__:__:__:__:__:__:__: negative

7. Reliability of output information:

high :__:__:__:__:__:__:__: low

superior :__:__:__:__:__:__:__: inferior

8. Relevancy of output information (to intended function):

useful :__:__:__:__:__:__:__: useless

relevant :__:__:__:__:__:__:__: irrelevant

9. Accuracy of output information:

accurate :__:__:__:__:__:__:__: inaccurate

high :__:__:__:__:__:__:__: low

10. Precision of output information:

high :__:__:__:__:__:__:__: low

definite :__:__:__:__:__:__:__: indefinite

11. Communication with the IS staff:

harmonious :__:__:__:__:__:__:__: dissonant

productive :__:__:__:__:__:__:__: unproductive

12. Time required for new systems development:

reasonable :__:__:__:__:__:__:__: unreasonable

acceptable :__:__:__:__:__:__:__: unacceptable

13. Completeness of the output information:

sufficient :__:__:__:__:__:__:__: insufficient

adequate :__:__:__:__:__:__:__: inadequate

Summary

1. How satisfied are you with your involvement and participation in the operation and ongoing development of information systems?

satisfied :__:__:__:__:__:__:__: not satisfied

2. How satisfied are you with the support and services of the IS department?

satisfied :__:__:__:__:__:__:__: not satisfied

3. How satisfied are you with the support and services of the IS department?

satisfied :__:__:__:__:__:__:__: not satisfied

4. In summary, how satisfied are you with the entire information systems environment?

satisfied :__:__:__:__:__:__:__: not satisfied

Are you primarily an information system user or developer? Please check only one. _____user _____developer

LIST OF REFERENCES

Alavi, M., "An Assessment of the Concept of Decision Support Systems as Viewed by Senior-Level Executives," *MIS Quarterly,* December 1982, pp. 1-9.

Alavi M., Carlson P. and Brooke G., "The Ecology of MIS Research: A Twenty Year Status Review," *Proceeding of the Tenth Conference on Information Systems,* Boston, December 1989, pp. 363-371.

Ameen, D,. "Systems Performance Evaluation," *Journal of Systems Management,* March 1989, pp. 33-36.

Amoroso, D. L., "Measuring the Effectiveness of New Emerging Technology," *Proceeding of the 23rd Hawaii Conference on System Sciences,* Hawaii, January 1990, pp. 405-407.

Bailey, J.E. and Pearson, S.W., "Development of A Tool for Measuring and Analyzing Computer User Satisfaction," *Management Science,* Vol. 29, No. 5, May 1983, pp. 530-545.

Bain, D., *The Productivity Prescription.* McGraw-Hill Book Company, 1982.

Baronas, A. K. and Louis, M. R., "Restoring a Sense of Control During Implementation: How User Involvement Leads to System Acceptance," *MIS Quarterly,* March 1988.

Baroudi,J. J., Oslon, M. H. and Ives, B. "An Empirical Study of the Impact of User Involvement on System Usage and Information Satisfaction," *Communication of the ACM,* Vol. 29, No. 3, March 1986, pp. 232-238.

Bearman, T. C., Guynup, P. and Milevski, S. N.,"Information and Productivity," *Journal of the American Society for Information Science,* Vol. 36, No. 6, November, 1985, pp. 369-375.

Borko, H. "Information and Knowledge Worker Productivity," *Information Processing and Management,* Vol. 19, No. 4, 1983, pp. 203-212.

Carlson, E. D., "Evaluating the impact of Information Systems," *Management Informatics,* Vol. 3, No.2, 1974, pp. 57-67.

Cash, J. I., Jr., McFarlan, F. W., McKenney, J. L., and Vitale, M. R., *Corporate Information Systems Management: Text and Cases,* 2nd ed., Homewood, Illinois, 1988.

Cerullo, M. J., "Determining Post-Implementation Audit Success," *Journal of Systems Management,* March 1989, pp. 27-31.

Chandler, J.S., "A Multiple Criteria Approach for Evaluating Information Systems," *MIS Quarterly,* Vol. 6 No. 1, March 1982, pp. 61-74.

Cheney, P.H. and Dickson, G.W., "Organizational characteristics and Information Systems: An Exploratory Investigation," *Academy of Management Journal,* Vol.25, No. 1, March, 1982, pp. 170-184.

Davis, J., and Srinivasan, A., "Incorporating User Diversity into Information Systems Assessment," *Information Systems Assessment,* Amsterdam, North Holland, 1988, pp. 83-98.

Edstrom, A., "User Influence and the Success of MIS Project: A Contingency Approach," *Human Relations,* Vol. 30, No. 7, 1977, pp. 589-607.

Ein-Dor P., and Segev E., "Organizational Context and the Success of Management Information Systems," *Management Science,* Vol. 24, No. 10, June, 1978, pp. 1067-1077.

Ein-Dor, P.; Segev, E.; Blumenthal, D.; and Millet, I., "Perceived Importance, Investment and Success of MIS or the MIS Zoo," *Systems, Objectives, Solutions,* Vol. 4, 1984, pp. 61-67.

Fishbein, M., and Ajzen, I., *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research,* Addison-Wesley, Reading, Massachussetts, 1975.

Franz, Charles R. and Robey, Daniel, "Organizational Context, User Involvement and The Usefulness of Information Systems," *Decision Sciences,* Vol. 17, No. 3, Summer 1986, pp. 329-355.

Galletta, D. F. and Lederer, A. L., "Some Cautions on the Measurement of User Information Satisfaction," *Decision Sciences,* Vol. 20, No. 3, Summer 1989, pp. 419-438.

Gibson, H. L., "Determining User Involvement," *Journal of Systems Management,* August 1977, pp. 20-22.

Ginzberg, M. J., "Finding an Adequate Measure of OR/MS Effectiveness," *Interfaces*, Vol. 8, No. 4, August 1978, pp.59-62.

Gremillion, L. L., "Organizational Size and Information Systems Use," *Journal of the Management of Information Systems*, Vol. 1, No. 2, Fall 1984, pp. 4-17.

Haga, W. J. and Zviran, M., "Information Systems Effectiveness: Research Designs for Causal Inference," Naval Postgraduate School, Monterey, California, August 1990.

Hamilton, S. and Chervany, N. L., "Evaluating Information System Effectiveness- Part I: Comparing Evaluation Approaches," *MIS Quarterly*, September 1981, pp. 55-66.

Hufnagel, E.M., "User Satisfaction- Are We Really Measuring System Effectiveness," *Proceeding of the 23rd Hawaii Conference on System Sciences*, Hawaii, January, 1990, pp. 437-446.

Ives, B. and Olson, M. H., "User Involvement and MIS Success: A Review of Research," *Management Science*, Vol. 30, No. 7, 1984, pp. 586-603.

Ives,B., Olson, M. H., and Baroudi, J.J., "The Measurement of User Information Satisfaction," *Communications of the ACM*, Vol. 26, No. 10, 1983, pp. 785-793.

Keen, P., "Value Analysis: Justifying Decision Support Systems," *MIS Quarterly*, March 1981, pp. 1-15.

Keim, R.T. and Janaro, R., "Cost Benefit Analysis of MIS," *Journal of Systems Management*, Vol. 33, No. 9, September 1982, pp. 20-25.

King, J.L. and Schrems, E.L., "Cost-Benefit Analysis in Information System Development and Operation," *Computing Surveys*, Vol. 10, No. 1, March 1978, pp. 19-34.

King, W.R. and Rodriguez, J.I., "Evaluating Management Information Systems," *MIS Quarterly*, Vol. 2, No. 3, September 1978, pp. 43-51.

Kleijnen, J.P.C., "Evaluation of Management Information Systems," *Omega*, Vol. 7, No. 6, 1979, pp. 539-543.

Larcker, D.F. and Lessig, P.V., "Perceived Usefulness of Information: A Psychometric Examination," *Decision Sciences*, Vol. 11, No. 1, January 1980, pp. 121-134.

Lay, P. M., "Beware of the Cost/Benefit Model for IS Project Evaluation," *Journal of Systems Management*, Vol. 36, No. 5, June 1985, pp. 30-35.

Lucas, H., Jr., "System Quality, User Reactions and The Use of Information Systems," *Management Informatics*, Vol. 3, No. 4, 1974, pp. 207-212.

Lucas, H. Jr., "Performance and The Use of Information Systems," *Management Science*, Vol. 21, No. 8, April 1975a, pp. 207-212.

Lucas, H., Jr., *Implementation: The Key to Successful Information Systems*, Columbia University Press, New York, New York, 1981.

Maggiolini, Piercarlo, "Office Automation Benefits: A Framework," *Information and Management*, Vol. 10, No. 2, 1986, pp.75-81.

Mahmood, M. A., and Becker, J. D., "Impact of Organizational Maturity on User Satisfaction with Information Systems," *21st Annual Computer Personnel Research Conference*, ACM, May 1985, pp. 134-151.

Markus, M. L., "Power Politics and MIS Implementation," *Communications of the ACM*, Vol. 26, No. 6, 1983, pp. 430-444.

Markus, M.L. and Robey, D., "The Organizational Validity of Management Information Systems," *Human Relations*, Vol. 36, No. 3, 1983, pp. 203-226.

Martin, M.P. and Trumbly, J.E., "Measuring Performance of Automated Systems," *Journal of Systems Management*, Vol. 37, No. 2, February 1986, pp. 7-17.

Mason, A., "Computers and Productivity," *Public Productivity Review*, Vol. 8, No. 1, March 1984, pp. 70-84.

Mason, R. O., "Measuring Information Output: A Communication Systems Approach," *Information and Management*, Vol. 1, No. 5, October 1978, pp 219-234.

Mathusz, D. V., "The Value of Information Concept Applied to Data Systems," *OMEGA*, Vol. 5, No. 5, 1977, p. 594.

Miller, J. and Doyle, B.A., "Measuring the Effectiveness of Computer-Based Information Systems in the Financial Sector," *MIS Quarterly*, Vol. 11, No. 1, March 1987, pp. 107-124.

Norton, D. and McFarlan, F. W., *The Information Systems Handbook,* Dow Jones-Irwin, Homewood, Illinois, 1975.

Radecki, Tadeusz, "New Approach to the Problem of Information System Effectiveness Evaluation," *Information Processing and Management,* Vol.12, No. 4, 1976, pp. 319-326

Raymond, L., "Organizational Context and Information Systems Success: A Contingency Approach," *Journal of Management Information Systems,* Spring 1990, Vol. 6, No. 4, pp. 6-20.

Robey, D. and Farrow, D., "User Involvement in Information Systems Development: A Conflict Model and Empirical Test," *Management Science,* Vol. 28, No. 1, January 1982, pp. 73-85.

Robey, D. and Zeller, R.L., "Factors Affecting the Success and Failure of an Information System for Product Quality," *Interfaces,* Vol. 8, No. 3, February 1978, pp. 70-75.

Sanders, G. L., "MIS/DSS Success Measure," *Systems, Objectives, Solutions,* Vol. 4, No. 1, 1984, pp. 29-34.

Schwartz, P., "Office Information Systems Cost Justification," *IEEE AES Magazine,* August 1986, pp. 21-25.

Sink, S. D., *Productivity Management: Planning, Measurement and Evaluation, Control and Improvement,* John Wiley and Sons, Inc., 1985.

Srinivasan, A., "Alternative Measures of System Effectiveness: Associations and Implications," *MIS Quarterly,* Vol. 9, No. 3, September 1985, pp. 256-259.

Srinivasan, A., and Kaiser, K., "Relationships Between Selected Organizational Factors and Systems Development," *Communications of the ACM,* Vol. 30, No. 6, June 1987, pp. 153-182.

Trice, A. W. and Treacy, M. E., "Utilization as a Dependent Variable in MIS Research," *Data Base,* Vol. 19, No. 3-4, Fall/Winter 1988, pp. 33-41

Tait, P. and Vessey, I., "The Effect of User Involvement on System Success: A Contingency Approach," *MIS Quarterly,* Vol. 12, No. 1, March 1988, pp. 91-108.

Weaver, W. and Shannon, C. E., *The Mathematical Theory of Communication,* Urbana, University of Illinois Press, 1963.

Worthley, John A., "Computer Technology and Productivity Improvement," *Public Productivity Review,* Vol. 4, No. 1, March 1980,pp. 10-20.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 52 Naval Postgraduate School Monterey, California 93942-5002	2
3.	Chairman, Code AS Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5100	1
4.	Professor William Haga, Code AS/Hg Department of Adminstrative Sciences Naval Postgraduate School Monterey, California 93943-5100	1
5.	Professor Moshe Zviram, Code AS/Zv Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5100	1
6.	Professor Tung Bui, Code AS/Bd Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5100	1
7.	LT Angela Cyrus N7-3, Building 3601 NAB Little Creek Norfolk, Virginia 23521-5000	1